

WHAT IS CLAIMED IS:

1. A method for *in situ*, stepwise, solid state synthesis of photosensitizers for titanium dioxide, comprising:
 - providing an anchor ligand having an anchoring end and a chelating end;
 - binding the anchoring end of the anchor ligand onto the titanium dioxide to give a bound anchor ligand with the chelating end;
 - incorporating a metal cation onto the chelating end of the bound anchor ligand to give a bound metal; and
 - binding one or more secondary ligands onto the bound metal.
2. The method of claim 1, wherein the anchor ligand comprises an azaaromatic ring structure, wherein the azaaromatic ring structure comprises one to four azaaromatic rings covalently joined to each other with between one and three covalent bonds, wherein the azaaromatic rings are substituted with one to four carboxy groups attached in place of any hydrogen on the perimeter of the azaaromatic ring system, and wherein there is only one carboxy group at any given azaaromatic ring position.
3. The method of claim 1, wherein the anchor ligand comprises a compound given in Figure 2 or a combination thereof.
4. The method of claim 1, wherein the metal cation comprises a transition metal cation.
5. The method of claim 1, wherein the metal cation comprises Ru, Cr, Mn, Fe, Co, Ni, Cu, Zn, Rh, Pd, Ag, In, Re, Os, Ir, Pt, or a combination thereof.
6. The method of claim 1, wherein the metal cation further comprises inorganic ligands, organic ligands, counterions, or a combination thereof.
7. The method of claim 1, wherein the one or more secondary ligands independently are the same or different and have a structure comprising one or more substituted or unsubstituted heterocyclic rings containing one or more nitrogen atoms.

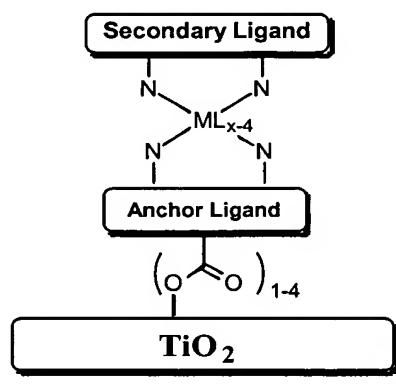
8. The method of claim 1, wherein the one or more secondary ligands independently are the same or different and comprise a compound given in Figure 3 or a combination thereof.
9. The photosensitizer for titanium dioxide prepared according to the method of claim 1.
10. A composition having a general structure:

TiO_2 —Anchor Ligand—M—Secondary Ligand,

wherein M is a metal cation.

11. The composition of claim 10, wherein M comprises a transition metal cation.
12. The composition of claim 10, wherein M comprises Ru, Cr, Mn, Fe, Co, Ni, Cu, Zn, Rh, Pd, Ag, In, Re, Os, Ir, Pt, or a combination thereof.
13. The composition of claim 10, wherein M further comprises inorganic ligands, organic ligands, counterions, or a combination thereof.
14. The composition of claim 10, wherein the anchor ligand comprises an azaaromatic ring structure, wherein the azaaromatic ring structure comprises one to four azaaromatic rings covalently joined to each other with between one and three covalent bonds, wherein the azaaromatic rings are substituted with one to four carboxy groups attached in place of any hydrogen on the perimeter of the azaaromatic ring system, and wherein there is only one carboxy group at any given azaaromatic ring position.
15. The composition of claim 10, wherein the anchor ligand comprises a compound given in Figure 2 or a combination thereof.
16. The composition of claim 10, wherein the secondary ligand comprises one or more secondary ligands.

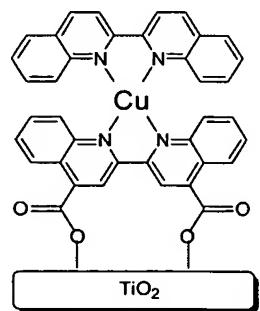
17. The composition of claim 16, wherein the one or more secondary ligands independently are the same or different and have a structure comprising one or more substituted or unsubstituted heterocyclic rings containing one or more nitrogen atoms.
18. The composition of claim 16, wherein the one or more secondary ligands independently are the same or different and comprise a compound given in Figure 3 or a combination thereof.
19. The composition of claim 10, wherein the general structure is:



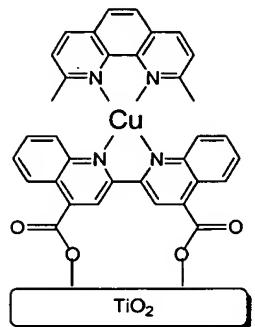
wherein L comprises an inorganic ligand, organic ligand, counterion, or a combination thereof; and

wherein x comprises an integer in a range of from four to six.

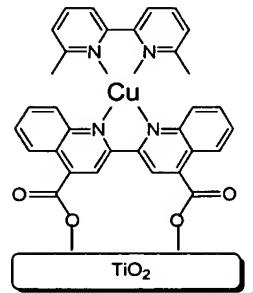
20. The composition of claim 19, wherein the structure is:



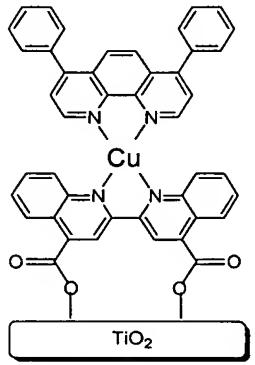
21. The composition of claim 19, wherein the structure is:



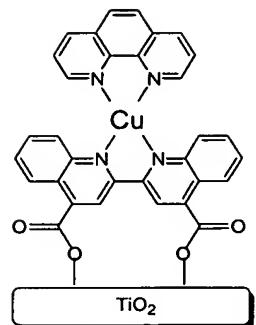
22. The composition of claim 19, wherein the structure is:



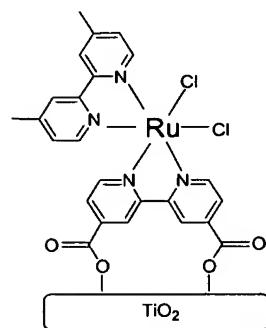
23. The composition of claim 19, wherein the structure is:



24. The composition of claim 19, wherein the structure is:



25. The composition of claim 19, wherein the structure is:



26. The composition of claim 19, wherein the structure is:

